

Bisphenol A in Register Receipts

It's Not Just for Dinner Anymore

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When we heat up a can of soup, we are getting more than we bargained for. Along with the vegetables and meat, we are getting a tagalong endocrine disruptor called bisphenol A (BPA) which leaches from the lining of the can. It has been known for many years that bisphenol A is found in baby bottles, food, aluminum cans, and dental sealants, but it is also in many other products we commonly are in contact with as well. The most surprising recent discovery is cash register receipts, where it is found, in some cases, at levels 250-1,000 times higher than in cans.

Why is it of concern? It is found not only in many consumer products, but also in amniotic fluid, breast milk, and our bodies. Decades of exhaustive research have linked this particular chemical in low doses with breast cancer, miscarriages, low sperm counts, prostate abnormalities, thyroid abnormalities, neurologic developmental abnormalities, and insulin resistance. There is special concern for pregnant women and the developing fetus.

BISPHENOL A HAS A DESISTER

Bisphenol A and its sister Diethylstilbestrol were studied to see if they could prevent miscarriages. BPA was synthesized in 1891 and was found to be estrogenic in 1930. At that time, a lot of interest was given to making synthetic estrogens. DES was found to be strongly estrogenic and was used to prevent miscarriages. As we know, it became associated with an increased risk of a rare vaginal cancer in the offspring of pregnant women who took it. Bisphenol A was found to be weakly estrogenic, thus was passed over for medical use. However, it later was found to prevent cracking of plastics, thus found many uses in consumer products. Despite the knowledge that BPA was estrogenic, it has been used to line food cans since the 1950s.

It is a high production volume chemical (over 1 million pounds per year),¹ which is used in a variety of consumer products including Nalgene bottles, clear plastic bottles,

PVC pipe, CDs, eyeglasses, enamel lining of cans, canned soda,²⁶ epoxy resins, toys, and in plastic #7. BPA is also known as polycarbonate and has been found to leach out of plastic and into water or foods, which until now has been thought to be the predominant source of human exposure.² Recently, it has been found in even higher levels in cash register receipts and other paper products. In some cases, the levels are 250 to 1,000 times higher than in food containers. Paper receipts are now of great concern as a significant consumer source of BPA.

WHAT IS AN ENDOCRINE DISRUPTOR?

The EPA defines an endocrine disruptor as an exogenous agent that interferes with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development, and/or behavior.²³

WIDESPREAD HUMAN EXPOSURE TO BPA

The Centers for Disease Control and Prevention (CDC) has found that 93% of Americans over six years of age have detectable urine levels of BPA, based on the National Health and Nutrition Examination Survey (NHANES).² BPA is found in breast milk at about 1.1 ng/ml.¹² BPA is found in amniotic fluid.¹⁶ The half-life of BPA is about two days, thus humans are exposed to BPA regularly on a daily basis via consumer products. About five-to-six billion pounds of bisphenol A are produced annually, worldwide, according to the CDC.¹¹

TOLERABLE DAILY INTAKE AND LEVELS OF CONCERN

Scientific risk assessments from the European Food Safety Authority and the FDA propose a Tolerable Daily Intake (TDI) limit of 50 micrograms per kilogram body weight or 0.5mg/kg body weight per day.²⁷

Adverse effects on animals, however, have been found in much lower levels in about 120 studies. These levels are what we may consume on a daily basis and are called clinically relevant doses.

ABUNDANT RESEARCH ON BPA

Some 1,000 studies have been done on BPA. It has been researched for decades and it has been associated with a wide range of adverse effects on endocrine systems including breast cancer, prostate cancer, diabetes, obesity, heart disease, diminished sperm production, early puberty, disruption of sexual differentiation in the brain, and developmental neurotoxicity at clinically relevant levels in the parts per trillion. It has endocrine disruption effects similar to DDT and PCB.³⁷ Bisphenol A is now listed as a chemical of concern by the EPA.³ The widespread use and exposure of this chemical makes it a significant threat to public health.

DEVELOPING FETUS AND CHILDREN MOST VULNERABLE

Recent research is finding that many adult diseases, such as infertility, have their origin during development. Irreversible "organizational" effects begin in the fetus and continue through puberty, resulting in adverse health effects, evident only in adulthood. As we know, growing infants and children are the second most vulnerable population as their brains, immune systems, reproductive systems, and breast tissue are immature at birth. Studies on rats and humans have demonstrated BPA can alter the course of normal neural development and can increase aggressive behavior.

PRENATAL BPA EXPOSURE

Prenatal exposure to BPA causes permanent adverse effects on the female reproductive tract, breast cancer induction, as well as abnormal neural development. Dr. Reth Newbold found that rats exposed to clinically relevant doses of BPA on days 9 and 16 of gestation showed abnormalities in the reproductive tracts at 18 months, none of which were seen in the control animals.

Researchers at Yale University found that BPA exposure during pregnancy caused permanent abnormalities of the uterus of the offspring, including alternation of DNA. Dr. Taylor found that the mice exposed to BPA as

a fetus had an exaggerated response to estrogens as adults, long after the exposure to BPA. The genes were permanently programmed to respond excessively to estrogen.¹⁰ Kubo found that prenatal exposure to BPA at levels below Tolerable Daily Intake (TDI) altered sexual differentiation reversing sex differences in open field behavior and diminishing brain centers responsible for sexual differentiation.¹³

THE BRAIN AND BPA

Adriani studied the perinatal effects of BPA on offspring of both sexes. He found the males to have a feminized profile.¹⁵ Xu et al found that perinatal exposure to BPA affects normal behavioral development in both spatial memory and avoidance memory, and also permanently influences the behavior of offspring in adulthood.¹⁹ Palanza looked at maternal oral exposure during the last part of gestation to a low, environmentally relevant dose of BPA (10 microg/kg bw/day) on behavioral responses of mouse offspring. They found that maternal exposure to BPA affected: (1) behavioral responses to novelty before puberty and, as adults; (2) exploration and activity in a free-exploratory open field; (3) exploration in the elevated plus maze; and (4) sensitivity to amphetamine-induced reward.

A consistent effect of exposure to BPA was the decrease or elimination of the sex difference in behavior. In addition, exposure of female mice to BPA in both adulthood or during fetal life altered subsequent maternal behavior. "These findings, together with those from other laboratories, are evidence of long-term consequences of maternal exposure to low-dose BPA at the level of neurobehavioral development."²¹ One mechanism of diminished brain development may be due to its antagonistic effect on thyroid hormone.¹⁷

BPA AND AGGRESSIVE BEHAVIOR

Prenatal exposure to bisphenol A (BPA) is known to increase aggression in offspring and diminish differences in sexually specific behaviors in rodents. Braun et al examined the association between prenatal BPA exposure and behavior in two-year-old children in a prospective study. They found BPA concentrations collected around 16 weeks were more strongly associated with externalizing (aggression, delinquency, and hyperactivity), and scores among all children and this association were stronger in females than in males.²³

ASTHMA AND BPA

BPA has been shown to induce mast cell

degranulation and enhance IgE-mediated release of allergic mediators in the perinatal period. They found significantly increased eosinophilic inflammation in the airways of the mice whose pregnant mothers were exposed to BPA compared to unexposed mothers.⁵

DIABETES AND BPA

Insulin resistance by BPA is thought to develop via its ability to mimic 17 β -estradiol. Insulin resistance is associated with type 2 diabetes and heart disease. M. Nathaniel Mead, a science writer who writes for *Environmental Health Perspectives*, writes of a study which exposed pregnant mice to BPA and evaluated glucose metabolism on the mother and subsequently on her offspring. They found the BPA-treated pregnant mice had aggravated insulin resistance and weighed more at four months postpartum. The male offspring had reduced glucose tolerance and increased insulin resistance than untreated mice.¹⁴

OBESITY AND BPA

Several studies have found that BPA produces obesity in mice. Recently, a new test was developed to discover the mechanism. Bisphenol A, as well as benzyl butyl phthalate, can modulate the signals controlling the number of fat cells produced and the uptake and storage of fats in those cells. More fat cells and fatter cells underlie weight gain in people.¹⁵

BREAST CANCER, DCIS, AND BPA

A substantial body of evidence indicates that exposure to bisphenol A (BPA) during early development may increase breast cancer risk later in life. A study by the Human Cancer Genetics Program at Ohio State University looked at epigenetic changes in breast epithelial cells and identified 170 genes with expression changes in response to BPA.²² Several studies

have shown BPA in utero to cause enhanced sensitivity to estradiol, decreased apoptosis, and increased the number of progesterone receptor-positive epithelial cells at puberty. In addition, research has demonstrated that prenatal BPA exposure in mice causes ductal hyperplasia and carcinoma in situ of the breasts. The fetal exposure was 2.5, 25, 250, and 1,000 micrograms bisphenol A/kg body weight. The TDI is 50. This indicates that current clinically relevant BPA levels appear "sufficient to induce the development of preneoplastic and neoplastic lesions in the mammary gland."¹⁸

BPA IN MEDICAL PRODUCTS

Because of concerns about BPA's effects on development, a study was carried out to see if BPA was found in newborns in neonatal intensive care units where there are no other outside influences. Levels of 30.3 micrograms per liter were found, which is a level of magnitude higher than the general population. A strong association was found with use of DEHP-containing products. DEHP is a phthalate chemical and known endocrine disruptor added to many commonly-used plastics to soften them. It is used in medical products, including IV bags and tubing.³¹ In May 2008, Health Canada announced a new requirement for those applying for a license for Class II, III, and IV medical devices to disclose the amount of BPA if it contains more than 0.1% BPA in the medical device or if BPA was used as a raw material in the production of the device.³⁵

BPA IN THERMAL PAPER PRODUCTS

New studies have found significant levels of BPA in thermal paper products. Dr. John Warner, professor of Community Health and Sustainability and Plastics Engineering at the



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University of Massachusetts-Lowell and one of the founding fathers of Green Chemistry, is a chemist who worked for Polaroid many years ago and learned of the thermal coating processes for paper. A powdery coating of BPA is laid down on the paper with a dye and a solvent. When heat or pressure is applied, the coatings' constituents merge to release the ink's color. After hearing about BPA in the news, he wondered if thermal paper still used BPA, and he had his university students run assays. The first study found levels of BPA from 0% – 1.7%.⁸

A 2010 University of Missouri study, looking at receipts from 36 different locations, found BPA in 40% of receipts and at levels averaging 1.9%. Safeway had the highest levels at 2.8% of the receipts' weight, although Whole Foods also had substantial BPA on their receipts. BPA has been found to stick to skin and can be transferred from hand-to-mouth, being absorbed in the digestive tract and possibly through the skin. In the Environmental Working Group Study, a damp wipe of four receipts demonstrated that 0.7% – 3.8% of the BPA easily wiped off.⁹ Those with sweaty palms beware. In a Swiss study published online July 11, 2010 in *Analytical and Bioanalytical Chemistry*, found that BPA transfers readily from receipts to skin and can penetrate skin to a level that it cannot be washed off.⁶

ALTERNATIVES TO THERMAL PAPER

Appleton Paper Company, which makes more than 50% of the receipt paper in the country, knew there would be issues with BPA and, in 2006, switched to a non-BPA process. "After reviewing available science, we concluded that removing BPA from our thermal products was the responsible thing to do. In doing so, we gave retailers and restaurants a safe, easy, and cost-competitive choice. Our BPA-free thermal receipt paper is available globally." (Appleton Papers August 9, 2010. www.appletonideas.com.)

RECYCLING BISPHENOL A: THE WATER CYCLE, THE FOOD CYCLE, THE POLLUTION CYCLE

Synthetic chemicals we produce are not biodegraded in the same way as natural chemicals and, thus, become part of the pollution cycle in our air, soil, water, and food. Many of the man-made chemicals are built to last and not biodegrade easily—fragrances with phthalates, soaps with nonylphenol, pesticides, anti-

cholesterol, and antidepressant medications (chemotherapy, anticholesterol, antidepressant)^{32,34}, chloramine in water, antibacterials such as triclosan, and, of course, bisphenol A. When these chemicals do degrade, they may also produce even more toxic substances, i.e. DDT to DDE.

In grade school, we learned about the water cycle, the soil cycle, the food cycle, etc. Natural substances are moved from one system to another. In our vital water cycle, the sun heats up water, which moves from lakes, rivers, oceans, and plants via evaporation and transpiration. Then, via condensation and precipitation, water comes back to the earth in the form of rain. The water returns to the lakes, rivers, oceans, and plants, and the cycle continues feeding new life on earth. We now know why cutting down the forest causes the rivers and streams to dry up. It ends the water cycle.

In the pollution cycle, many of the man-made chemicals we use everyday may not only bioaccumulate in us, they are also excreted from us to sewage sludge and also thrown away in the garbage. In this way, through different routes, they end up in the water and soil, continuing to pollute the entire food chain, from the basic aquatic life forms, to fish, to mammals, to us again.

WHAT WE POUR DOWN THE SINK, WE EVENTUALLY DRINK

We know municipal water contains many man-made substances that are now part of the water cycle, including personal care products and pharmaceuticals.³³ It is the job of regional water quality control boards to monitor these human pollutants and try to remove them. It is an expensive proposition. Waste water contains all of these pollutants which we flush or pour down our drains including bisphenol A. We are now recycling waste water as well as discharging most of these synthetic chemicals into our bay. What effect is it having on the ecology of the Bay and us? Why not prevent the pollutants from going into the pipe in the first place?

In the human waste stream, scientists have found pollutants such as brominated flame retardants as well. They look at sewage sludge, which is considered an "organic" compost and soil amendment used daily on our large agricultural fields. It contains a multitude of pollutants which are monitored, and some limits are placed on some known contaminants.

BISPHENOL A IN RECYCLED PAPER

Bisphenol A has a special role as a recycled pollutant in the waste stream as it is used in paper products and now is found in recycled toilet paper in significant amounts – up to 430 mg/kg dry mass. This is due to the fact that cash register receipts and ATM receipts, 40 % of which contain significant amounts of BPA, are recycled with regular paper. "Because of the distinct contamination with xenoestrogens, both paper waste and recycled paper products should not be mixed with biological waste."¹ BPA is also found in recycled cardboard and there also may be other paper products not yet recognized as a significant source of BPA.

TOP SOURCES OF BPA TO AVOID

BPA is used in thousands of consumer products. Here are some common sources:

1. Polycarbonate clear plastic shatterproof containers—Nalgene water bottles, baby bottles.
2. Many Sassy baby products, including those that change color.
3. Aluminum water bottles lined with an enamel coating to prevent leaching of aluminum.
4. Soda cans.
5. Beer and wines fermented in metal vats, lined with BPA.
6. Credit card receipts.
7. Credit cards.
8. Pizza boxes with recycled cardboard.
9. Recycled toilet paper.
10. Canned goods — even canned organic tomatoes.
11. Many hard plastic dishes and cups — Plastic #7.
12. Blue-tinted five gallon drinking water bottles — plastic #7 or polycarbonate.
13. CDs.

MANY STATES ARE BANNING BPA IN CHILDREN'S PRODUCTS

Because of the vast amount of data showing harm of this estrogen-mimicking chemical in very low doses, 20 states are in the process of banning BPA in baby products. Suffolk County, NY was the first county in the U.S. to ban BPA. Several states — Connecticut, Washington, Oregon, Minnesota, and New York — already have passed legislation to reduce BPA exposure. In June 2010, in a unanimous vote, both the Senate and Assembly of the New York State Legislature voted to ban the sale of paci-

fiers, baby bottles, sippy cups, and straws containing BPA. The statewide ban in Connecticut included not only baby food cans and jars, but also reusable food and beverage containers without an age limit. Washington became the fifth state to pass a ban which included not only drink cups and bottles used by kids under three years old, but also water bottles. Federal legislation has also been introduced to remove BPA from canned goods and food containers (HR 1523).¹ In addition, there is legislation to ban BPA as a contaminant in foods via the proposed Federal Food Safety Bill (S 510). This would also expand the FDA's authority over food processing and production.

California introduced Pavley SB 797, which bans BPA not only in baby bottles, but also in canned beverages and food containers for children three-and-under. This passed the Assembly and all committees in the Senate. It was ultimately killed in the Senate due to attacks by the chemical industry claiming there would be no more baby formula, as these cans are lined with BPA.

CANADA AND AUSTRALIA HAVE BANNED BPA IN SOME CONSUMER PRODUCTS

Canada has voluntarily banned BPA in all baby bottles, as of 2008. In June 2010, the Australian government announced the phaseout of polycarbonate plastic baby bottles with BPA.

CONCLUSION: BEYOND BPA

It appears that science has produced overwhelming evidence that BPA is toxic and widespread at environmentally-relevant levels. As a potent endocrine disruptor, it alters normal endocrine function and is especially harmful to pregnant women and the developing fetus, as well as children. This dangerous chemical should be removed from most, if not all, consumer products in a phased fashion, beginning with any container or product used for food or water, medical devices, thermal paper, and then beyond.

CMA RESOLUTION PASSED

At the 2010 House of Delegates, the CMA passed a resolution to call for the reduction, towards elimination, of BPA in all consumer products. Hopefully, legislation to reduce harm from this chemical and others will get some traction in the new year.

Removal of bisphenol A from consumer paper products — 116-10

Resolved: that the CMA recognizes a public health concern for bisphenol A, a known

endocrine disruptor, and endorses efforts to reduce, towards elimination, BPA in consumer products including food containers, baby products, and thermal paper products.

REFERENCES BPA

For a full report of all references, visit www.sccma-mcems.org and click on the "Going Green" tab.

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